

**WHAT IS CLAIMED IS:**

- 1           1.       A fuel cartridge that supplies a source of fuel to a direct methanol fuel cell, the  
2 fuel cartridge comprising:  
3           a housing;  
4           a fuel egress to allow contents in the housing to escape from the housing; and  
5           a surface area enhanced planar vaporization membrane residing in the fuel cartridge.
- 1           2.       The fuel cartridge of claim 1 wherein the surface area enhanced planar  
2 vaporization membrane is a polymer membrane disposed about a substantial portion of an  
3 interior of the housing to provide a high surface area membrane.
- 1           3.       The fuel cartridge of claim 1 wherein the surface area enhanced planar  
2 vaporization membrane is a composite membrane comprised of multiple layers or folds of  
3 polymer membrane to increase vapor permeation surface area.
- 1           4.       The fuel cartridge of claim 1 wherein the surface area enhanced planar  
2 vaporization membrane is a membrane arranged as a series of folds.
- 1           5.       The fuel cartridge of claim 1 wherein the surface area enhanced planar  
2 vaporization membrane is a polymer membrane provided with macroscopically irregular  
3 and/or microscopically roughened membrane surfaces to increase the effective membrane  
4 surface area for vaporization.
- 1           6.       The fuel cartridge of claim 1 wherein the surface area enhanced planar  
2 vaporization membrane spaces a liquid source of oxidizable fuel from a vapor phase of the  
3 source of oxidizable fuel.
- 1           7.       The fuel cartridge of claim 1 wherein the cartridge contains a liquid source of  
2 oxidizable fuel and/or a carbonaceous compound or mixture of such compounds.
- 1           8.       The fuel cartridge of claim 1 wherein the liquid source of oxidizable fuel is  
2 methanol.

1           9.       The fuel cartridge of claim 1 wherein the enhanced planar vaporization  
2 membrane is comprised of a polymer material selected from the group consisting of  
3 polyurethanes, silicones, poly(trimethylsilyl-propyne), polymeric compositions, and  
4 composites.

1           10.      The fuel cartridge of claim 1 wherein the surface area enhanced planar  
2 vaporization membrane enhances a delivery rate of methanol in a vapor phase to the egress  
3 port for a given cartridge size.

1           11.      A fuel cartridge that supplies a source of fuel to a direct methanol fuel cell, the  
2 fuel cartridge comprising:  
3           a housing;  
4           a fuel egress port supported by the housing; and  
5           a composite membrane residing in the fuel cartridge comprising:  
6                 a porous substrate;  
7                 a polymer membrane disposed over a first surface of the porous substrate; and  
8                 a coating of a methanol-impermeable material disposed over an opposite  
9 surface of the substrate.

1           12.      The fuel cartridge of claim 11 wherein substrate is provided to hold methanol  
2 in a liquid state within the porous material to enable liquid methanol to migrate to the  
3 polymer membrane and convert to a vapor phase.

1           13.      The fuel cartridge of claim 11 wherein the composite membrane is wound into  
2 a cylindrical shaped element.

1           14.      The fuel cartridge of claim 11 wherein gaps between the polymer membrane  
2 and the methanol-impermeable coating providing a path for transporting a high flux of  
3 methanol vapor to the egress port.

1           15.     The fuel cartridge of claim 11 wherein a plurality of the composite  
2 membranes are disposed in the fuel cartridge.

1           16.     The fuel cartridge of claim 11 wherein a plurality of the composite  
2 membranes are disposed in the fuel cartridge and wound into a cylindrical shaped element.

1           17.     The fuel cartridge of claim 11 wherein the substrate is polyethylene,  
2 polypropylene, nylon, polyurethane, or other analogous polymers or composites of one or  
3 more of these polymers.

1           18.     The fuel cartridge of claim 11 wherein the polymer membrane is a  
2 polyurethane material.

1           19.     The fuel cartridge of claim 18 wherein the polymer material is selected from  
2 the group consisting of polyurethanes, silicones, poly(trimethylsilyl-propyne), polymeric  
3 compositions, and composites.

1           20.     The fuel cartridge of claim 18 wherein the polymer has a microporosity  
2 characteristic to govern vaporization.

1           21.     The fuel cartridge of claim 11 wherein the membrane is a sintered metal disc  
2 coated with a polymer.

1           22.     The fuel cartridge of claim 11 wherein the methanol-impermeable coating is a  
2 cross-linked rubber, a polymer/inorganic composite, a surface fluorinated high density  
3 polyethylene, or other methanol-impermeable material.

1           23.     The fuel cartridge of claim 11 wherein the substrate is polyethylene,  
2 polypropylene, nylon, polyurethane, or other analogous polymers or composites of one or  
3 more of these polymers; the polymer membrane is polyurethanes, silicones,  
4 poly(trimethylsilyl-propyne), or composites of polyurethanes, silicones, poly(trimethylsilyl-  
5 propyne) and the methanol-impermeable coating is a cross-linked rubber, a

6 polymer/inorganic composite, a surface treated material such as surface fluorinated high  
7 density polyethylene, or other methanol-impermeable material.

1           24.     A composite membrane residing in the fuel cartridge comprising:  
2                     a porous substrate;  
3                     a polymer membrane disposed over a first surface of the porous substrate; and  
4                     a coating of a methanol-impermeable material disposed over an opposite  
5                     surface of the substrate.

1           25.     The membrane of claim 24 wherein substrate is provided to hold methanol in  
2                     a liquid state within the porous material to enable liquid methanol to migrate to the polymer  
3                     membrane and convert to a vapor phase.

1           26.     The membrane of claim 24 wherein the composite membrane is wound into a  
2                     cylindrical shaped element.

1           27.     The membrane of claim 24 wherein gaps between the polymer membrane and  
2                     the methanol-impermeable coating providing a path for transporting a high flux of methanol  
3                     vapor.

1           28.     The membrane of claim 24 wherein the substrate is polyethylene,  
2                     polypropylene, nylon, polyurethane, or other analogous polymers or composites of one or  
3                     more of these polymers.

1           29.     The membrane of claim 24 wherein the polymer material is selected from the  
2                     group consisting of polyurethanes, silicones, poly(trimethylsilyl-propyne), polymeric  
3                     compositions, and composites.

1           30.     The membrane of claim 24 wherein the polymer has a microporosity  
2                     characteristic to govern vaporization.

1           31.     The membrane of claim 24 wherein the membrane is a sintered metal disc,  
2     coated with a polymer.

1           32.     The membrane of claim 24 wherein the methanol-impermeable coating is a  
2     cross-linked rubber, a polymer/inorganic composite, a surface fluorinated high density  
3     polyethylene, or other methanol-impermeable material.

1           33.     The membrane of claim 24 wherein the substrate is polyethylene,  
2     polypropylene, nylon, polyurethane, or other analogous polymers or composites of one or  
3     more of these polymers; the polymer membrane is polyurethanes, silicones,  
4     poly(trimethylsilyl-propyne), or composites of polyurethanes, silicones, poly(trimethylsilyl-  
5     propyne) and the methanol-impermeable coating is a cross-linked rubber, a  
6     polymer/inorganic composite, a surface treated fluorinated high density polyethylene.

1           34.     An arrangement comprises:  
2             a direct methanol fuel cell;  
3             a fuel cartridge that supplies a source of fuel to the direct methanol fuel cell, the fuel  
4     cartridge comprising:  
5             a housing;  
6             a fuel egress port supported by the housing; and  
7             a surface area enhanced planar vaporization membrane residing in the fuel cartridge  
8     and  
9             a fuel reservoir that receives fuel from the fuel cartridge, the fuel reservoir arranged  
10    to deliver fuel to the fuel cell and the fuel reservoir comprising:  
11            a housing; and  
12            a surface area enhanced planar vaporization membrane residing in the fuel reservoir,  
13    which in combination with the surface area enhanced planar vaporization membrane residing  
14    in the fuel cartridge provides a dual stage vaporization of fuel to the fuel cell.

1           35.     The arrangement of claim 34 wherein at least one of the surface area enhanced  
2 planar vaporization membranes is a polymer membrane disposed about a substantial portion  
3 of an interior perimeter of the housing to provide a high surface area membrane.

1           36.     The arrangement of claim 34 wherein at least one of the surface area enhanced  
2 planar vaporization membranes is a composite membrane comprised of multiple layers or  
3 folds of polymer membrane to increase vapor permeation surface area.

1           37.     The arrangement of claim 34 wherein at least one of the surface area enhanced  
2 planar vaporization membranes is a membrane arranged as a series of folds.

1           38.     The arrangement of claim 34 wherein at least one of the surface area enhanced  
2 planar vaporization membranes is a polymer membrane provided with macroscopically  
3 irregular and/or microscopically roughened membrane surfaces to increase the effective  
4 membrane surface area for vaporization.

1           39.     A method of operating an electronic device comprises:  
2           arranging a fuel cartridge to supply a source of fuel to a direct methanol fuel cell, the  
3 fuel cartridge comprising:  
4           a housing;  
5           a fuel egress port supported by the housing; and  
6           a composite membrane residing in the fuel cartridge comprising:  
7                 a porous substrate;  
8                 a polymer membrane disposed over a first surface of the porous substrate; and  
9                 a coating of a methanol-impermeable material disposed over an opposite  
10           surface of the substrate.